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Tracking passive sentence comprehension in agrammatic aphasia

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ABSTRACT

People with agrammatic aphasia often experience greater difficulty comprehending passive compared to active sentences. The Trace Deletion Hypothesis (TDH; Grodzinsky, 2000) proposes that aphasic individuals cannot generate accurate syntactic representations of passive sentences and, hence, use an agent-first processing strategy which leads to at-chance performance. We tested this claim using the eye tracking-while-listening paradigm in order to reveal online processing routines. Ten agrammatic aphasic participants and 10 age-matched controls listened to passive and active sentences and performed a sentence-picture matching task (i.e., selecting between two pictures with reversed thematic roles), while their eye movements were monitored. Control participants' performance was at ceiling, whereas accuracy for the aphasic participants was above chance for active sentences and at chance for passive sentences. Further, for the control participants, the eye movement data showed an initial agent-first processing bias, followed by fixation on the correct picture in the vicinity of the verb in both active and passive sentences. However, the aphasic participants showed no evidence of agent-first processing, counter the predictions of the TDH. In addition, in active sentences, they reliably fixated the correct picture only at sentence offset, reflecting slowed processing. During passive sentence processing, fixations were at chance throughout the sentence, but different

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patterns were noted for correct and incorrect trials. These results are consistent with the proposal that agrammatic sentence comprehension failure involves lexical processing and/or lexical integration deficits.

1. Introduction

People with agrammatic aphasia often have difficulty comprehending sentences with non-canonical word orders, in which the linear order of noun phrases (NPs) within a sentence does not match their semantic prominence (e.g., Caplan & Futter, 1986; O'Grady & Lee, 2005; Schwartz, Saffran, Linebarger, & Pate, 1987; Schwartz, Saffran, & Marin, 1980). For instance, aphasic individuals often experience greater difficulty understanding passive sentences, in which the theme precedes the agent (e.g., *The boy was pushed by the girl*) than canonical active sentences (e.g., *The girl pushed the boy*), a pattern that has been found across a variety of languages, including English, Dutch, German, Italian, and Turkish (Bastiaanse & Edwards, 2004; Burchert & De Bleser, 2004; Grodzinsky, Piñango, Zurif, & Drai, 1999; Linebarger, Schwartz, & Saffran, 1983; Luzzatti et al., 2001; Yarbay Duman, Altinok, Özgirgin, & Bastiaanse, 2011). They also exhibit impaired ability to understand structures with syntactically-displaced objects, in which the theme of the embedded clause precedes the agent, such as object-relative clauses and clefts (e.g., object cleft: *It was the boy$_i$ that the girl pushed* ___$_i$) (Grodzinsky, 1989; Grodzinsky et al., 1999).

On the basis of these and related findings, some researchers claim that agrammatic aphasia involves impaired representation or processing of syntactic dependencies (Burkhardt, Piñango, & Wong, 2003; Grodzinsky, 1986, 1989, 2000; Mauner, Fromkin, & Cornell, 1993; Zurif, Swinney, Prather, Solomon, & Bushell, 1993). Transformational models of syntax claim that in non-canonical structures such as passives, object-relative clauses, and object clefts, the object is moved from its position following the verb, and a trace (or copy) of this movement is left in the original object position (Chomsky, 1986, 1993, 1995; Marantz, 1995). Evidence from cross-modal lexical priming has supported the view that the process of associating the moved element (the *filler*) with its original position (the *gap*) may be absent or delayed in agrammatic aphasia. Some studies show, for example, that in contrast to individuals with Wernicke's aphasia and healthy controls, people with Broca's aphasia do not show evidence of re-activation of the agent at the gap site in subject-relative clauses (e.g. *The gymnast loved the professor$_i$ from the northwestern city who$_i$* ___$_i$ *complained about the bad coffee*; Zurif et al., 1993). Other studies show, however, that gap-filling effects do occur but are delayed relative to healthy controls, for example, in *wh*-movement structures such as object-relative clauses (Burkhardt et al., 2003; Love, Swinney, & Zurif, 2001).

Other recent studies show a different pattern. That is, using eye tracking-while-listening paradigms individuals with agrammatic (Broca's) aphasia show both successful and timely filler-gap processing in *wh*-structures (Dickey, Choy, & Thompson, 2007; Dickey & Thompson, 2009; Thompson & Choy, 2009; also see Blumstein et al., 1998). For example, Dickey et al. (2007) asked participants to listen to stories such as (1) as they viewed visual arrays of four pictures depicting the two participants in the event (e.g., a boy, a girl), the location of the event (e.g., a school), and an unrelated distractor object (e.g., a door).

1) This story is about a boy and a girl.
   One day, they were at school.
   The girl was pretty, so the boy kissed the girl.
   They were both embarrassed after the kiss.

Following each story, *wh*-questions were presented (e.g. *Who$_i$ did the boy kiss* ___$_i$ *that day at school?*) as their eye movements were tracked. Aphasic participants performed significantly more poorly on the behavioral task than control participants, however they, like healthy control listeners, showed evidence of online gap-filling by looking at the picture depicting the filler (e.g., *girl*) at the gap site (cf. Sussman & Sedivy, 2003). Dickey and Thompson (2009) found similar patterns for object-relative structures. Interestingly, in both studies gap-filling effects were found for both correctly and